

## Hybrid Fuel Cell Technology Overview CD

For the purpose of this CD and unless otherwise stated, hybrid fuel cell systems are power generation systems in which a high temperature fuel cell is combined with another power generating technology. The resulting system exhibits a synergism in which the combination performs with efficiency far greater than can be provided by either system alone. Hybrid fuel cell designs under development include fuel cell with gas turbine, fuel cell with reciprocating (piston) engine, and designs that combine different fuel cell technologies. Hybrid systems have been extensively analyzed and studied over the past five years by the Department of Energy (DOE), industry, and others. These efforts have revealed that this combination is capable of providing remarkably high efficiencies. This attribute, combined with an inherent low level of pollutant emission, suggests that hybrid systems are likely to serve as the next generation of advanced power generation systems.

This potential, while impressive, will require substantial development effort if it is to be realized. Balance-of-plant issues, the required infrastructure, and the resolution of technical hurdles that are as yet ill defined, will all have to be addressed. Given what we presently know about the various hybrids, a variety of technical issues are likely to emerge in the near-term:

- High temperature heat exchangers and the associated materials will need to be developed.
- New gas turbine designs will be required with pressure ratios, firing temperatures, and operating conditions adjusted to optimize the system cycle efficiency and reduce costs.
- Gas turbine recuperation and intercooling developments will be needed.
- Systems reliability and operability will have to be established and optimized for selected cycles. This will include startup, load matching, and system upset.

Developing hybrid power cycles will be a complicated and difficult process. The power cycles consist of a series of modules or building blocks. Many of these blocks are available or will be available in the near future. Many such building blocks or subsystems are under development in programs that are partnered by the National Energy Technology Laboratory (NETL), and U.S. industry. These key subsystems include the products of the advanced turbine systems programs and various fuel cells also developed under NETL sponsorship. By carefully integrating these developed subsystems, with the results of future programs aimed at solving the remaining technical challenges, hybrid power cycles will become a reality. These early hybrid systems will provide efficiencies of 60 percent or higher and will meet the required emissions and cost criteria necessary to be successful in the marketplace.